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Transfer box with crown teeth

Description

The invention relates to a transfer box with a housing, an input shaft, a first output shaft extending coaxially relative to said input shaft, and a second output shaft extending parallel to said first output shaft and said input shaft, as well as with a differential gear assembly arranged between said shafts.

In vehicles with two permanently driven axles, transfer boxes of said type, on the one hand, serve to drive a rear axle through a first output shaft and, on the other hand, they serve to drive a front axle through a second output shaft which, as a rule, is offset relative to and extends parallel relative to the input shaft. The torque can be uniformly distributed between the output shafts by means of the differential gear assembly or a biased torque load can be applied to one of the output shafts.

The torque distribution in transfer boxes of this type is commonly effected by planetary gear differential assemblies for dividing the torque between the front axle and the rear axle; they are characterised by a large number of parts, complicated assembly procedures and by this high costs, more particularly if they are provided in the form of double planetary differentials to achieve a uniform torque distribution.

It is therefore the object of the present invention to propose a transfer box with a differential gear assembly in a simplified design. The objective is achieved by a transfer box of the type mentioned wherein the input shaft carries a spider member with a plurality of radial bearing arms for the differential gears, wherein a first side gear is connected to the first output shaft in a rotationally fast way and wherein a second side gear is rotatably supported on the input shaft, which second side gear drives the second output shaft, wherein the differential gears are spur gears and the side gears are crown gears, with the teeth of the differential gears engaging the teeth of the side gears.

The differential gears supported with radial axes between the side gears are directly supported on the input shaft, which results in a very small number of parts. The torque is introduced directly via the input shaft and the radial arms into the differential gear assembly. Generally speaking, a differential carrier carrying the differential gears is eliminated in this case.

According to a particularly advantageous embodiment, a gearwheel or sprocket wheel for driving the second output shaft via a gearwheel stage or chain drive is integrally connected to the second side gear. Again, the number of parts is reduced.

According to a further advantageous embodiment, it is proposed that the input shaft and the first output shaft are each singly supported in the housing and that the input shaft is supported by means of a journal projection in a countersunk end portion in the first output shaft, more particularly by a needle bearing.

According to a first embodiment it is proposed that, in respect of the axial forces generated by the tooth forces in the direction of the shafts, the side gears are supported in the housing by the bearing means of the input shaft and of the first output shaft. More particularly, outwardly directed axial forces have to be accommodated by the housing. The tooth play can be set by selecting suitable discs which are placed underneath at least one of the side gears.

According to a second embodiment it is possible for the side gears to support each other axially, with a carrier being connected to one side gear which carrier extends over the first side gear and via which the other side gear is axially supported on the first mentioned side gear. An axial bearing or friction discs can be provided between the carrier and the outside of the second side gear. An axial bearing generates the effect of an open differential, whereas the friction discs can generate a friction moment which inhibits the differential effect. The axial forces generated by the tooth forces are compensated for as inner forces via the carrier. The tooth play can be set by using discs at the axial bearing or by accurately positioning the carrier on the other sideshaft gear prior to connecting the two parts to one another. The element referred so as carrier in this context and serving to support the two side gears relative to one another can be cost-effectively produced in the form of a deep-drawn metal part.

According to a further embodiment it is proposed that, for the purpose of a non-uniform torque distribution between the output shafts, the side gears comprise different rolling circle radii.

Due to the crown gear teeth design, it is possible to vary the torque distribution between the output shafts and thus between the driving axles simply by exchanging the side gear teeth while otherwise leaving the design unchanged. This is due to the fact that the crown gear teeth are insensitive to the axial positioning of the spur gears in rolling contact with the crown gears, with reference to the axis of the spur gears.

The above-described invention provides a simple differential assembly wherein drive is effected from the centre via the carrier spider member of the differential gears. The axial forces acting on the side gears can be supported directly on the housing if a carrier in the conventional sense has not been provided.

Preferred embodiments of the invention are illustrated in the drawings and will be described below.

Figure 1 shows an inventive transfer box in a section through the plane of the axes in a first embodiment.

Figure 2 shows an inventive transfer box in a section through the plane of the axes in a second embodiment.

Figure 3 shows an inventive transfer box in a section through a plane of the axes in a third embodiment.

Figure 4 shows an inventive transfer box in a section through the plane of the axes in a fourth embodiment.

Figures 1 to 3 will initially be described jointly to the extent that their respective designs correspond to one another.

They each show an inventive transfer box whose housing 11 is shown in principle only and which can be divided in the drawing plane for example. An input shaft 12 and a first output shaft 13 are arranged coaxially relative to one another on a first axis A1. A second output shaft 14 is rotatably arranged on a second axis A2 which extends parallel to the axis A1. The input shaft 12 is supported via a ball bearing in a second housing aperture. A journal projection 18 engaging a central recess 19 in the first output shaft 13 is provided at the input shaft 12, with the journal projection 18 being supported via a needle bearing 20 in the recess 19. The input shaft 12 comprises shaft teeth 21 which adjoin the journal projection 18 and on to which there is slid a spider member 23 which comprises corresponding inner teeth and which is provided with three circumferentially distributed radial bearing arms 24. The bearing arms carry differential gears 25 provided in the form of spur gears. The spur gears 25 engage a first side gear 26 which is slid on to the first output shaft 13 and which is connected thereto in a rotationally fast way, as well as a second side gear 27 which is slid on to the input shaft 12 and rotatably supported thereon via needle bearings 28. The second sideshaft gear 27 is integrally produced with a chain gear 29 which, via a chain 30, drives the second output shaft 14. The chain 30 directly engages the chain gear 31 which, by means of corresponding inner teeth, is slid on to the shaft teeth 22 of the second output shaft 14. The second output shaft 14 is supported in the housing 11 via bearings 32, 33 which are held by a cover 40.

In Figure 1, the second sideshaft gear 27 is supported by the gear 29 via discs 34, 35 and a second axial bearing 36 on the bearing 15, with the bearing means being such that at least outwardly directed axial forces can be accommodated by the bearing means. The play in the inter-engaging teeth of the

differential gears 25 and the sideshaft gears 26, 27 can be set by selecting the discs. The bearing means of the first output shaft 13, too, have to be designed in such a way that at least the axial forces acting outwardly on the shaft can be supported by said bearing means.

Figure 2, instead of showing the assembly consisting of discs 34, 35 and axial bearings 36 for supporting the first sideshaft gear 27, shows an assembly consisting of a dish-shaped carrier 37 and a needle bearing 38 for axially supporting the second sideshaft gears 27 towards the outside. Said carrier 37 is firmly connected to the second sideshaft gear 27 and extends over the first sideshaft gear 26 in such a way that a needle bearing 38 inserted between the carrier 37 and the outside of the second sideshaft gear 27 accommodates the axial forces acting between the first sideshaft gear 26 and the second sideshaft gear 27. The bearings 15, 16 are substantially load-relieved as regards the outwardly acting axial forces.

Figure 3, instead of the above-mentioned needle bearing 38, shows a friction disc assembly 39 inserted between the carrier 37 and the outside of the second sideshaft gear 27. Like the needle bearing, the friction disc assembly 39 accommodates the axial forces acting between the first sideshaft gear 26 and the second sideshaft gear 27, but it generates a friction moment when the sideshaft gears 26, 27 rotate relative to one another. As a result, a locking moment, which increases with increasing tooth forces, is built up in the differential gear assembly. The tooth forces themselves increase together with the torque introduced via the input shaft.

Figure 4 shows a differential drive in the same embodiment as illustrated in Figure 2, but the side gears 26′, 27′ have different diameters, as a result of which the differential gears 25′ comprise an increased axial tooth length. The side gears 26′, 27′ show the different rolling circle radii r_1, r_2. In this embodiment, the second output shaft 14 is subjected to a higher torque than the first output shaft 13.

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List of reference numbers

11	housing
12	input shaft
13	first output shaft
14	second output shft
15	bearing
16	bearing
17	-
18	journal projection
19	countersunk portion
20	needle bearing
21	shaft teeth
22	shaft teeth
23	cross member
24	bearing arm
25	differential gear
26	first side gear
27	second side gear
28	needle bearing
29	chain gear

30	chain
31	chain gear
32	bearing (14)
33	bearing (14)
34	disc
35	disc
36	axial bearing
37	carrier
38	axial bearing
39	friction discs